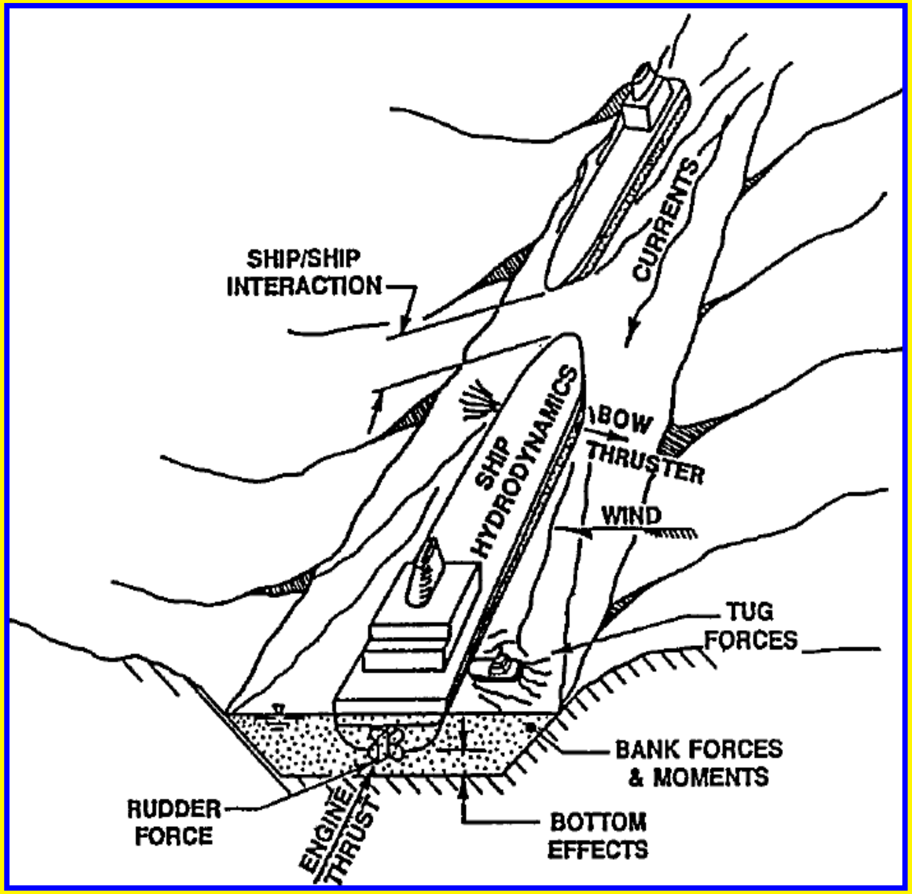
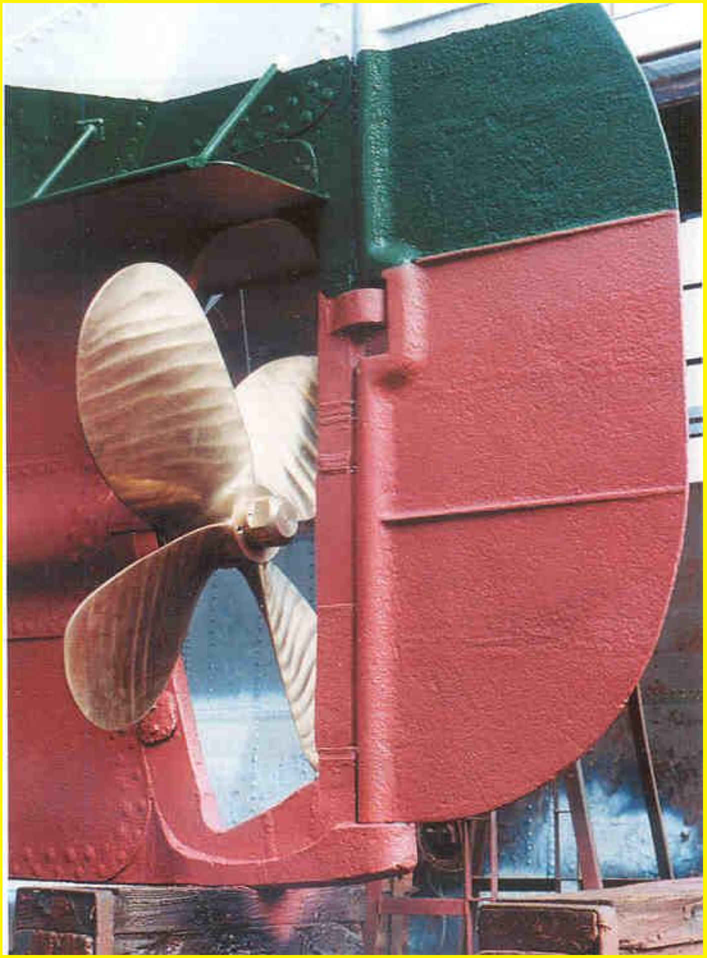
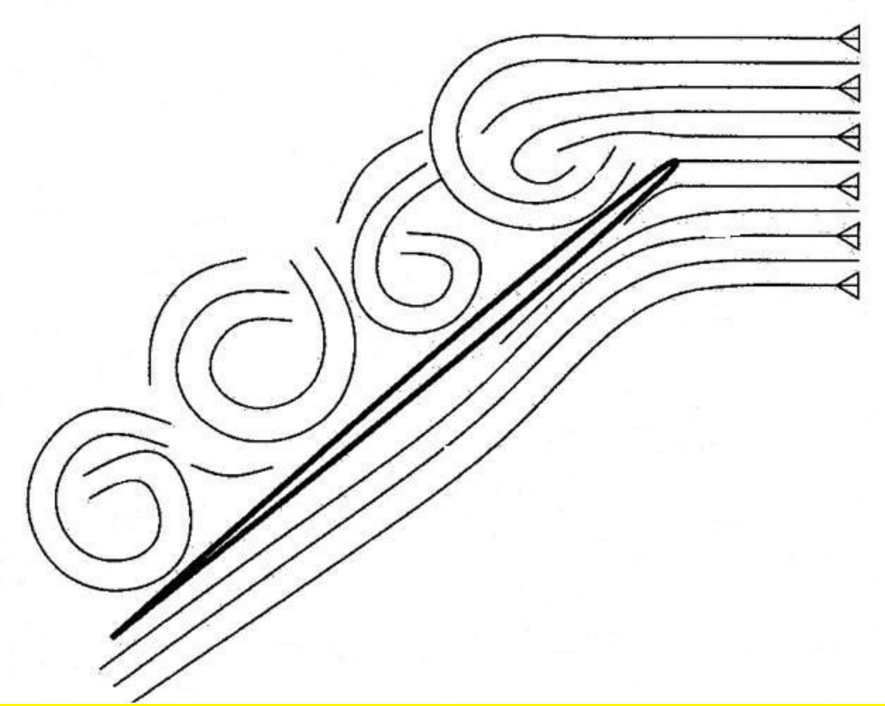
Shiphandling Theory

- **There may be more than a dozen forces acting about the vessel's axis at a given moment, and the resultant may not be as anticipated but due partially to a force which has escaped discovery. This is not 'mysticism' as much as lack of the research which takes the art of shiphandling into the finite world of applied science.**
  - **P.F. WILLERTON, BASIC SHIPHANDLING**

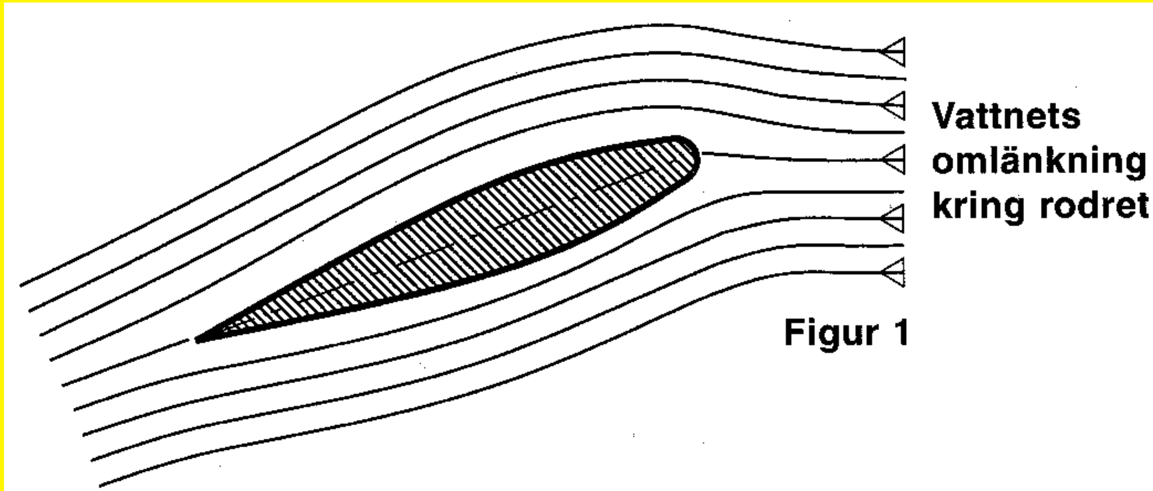


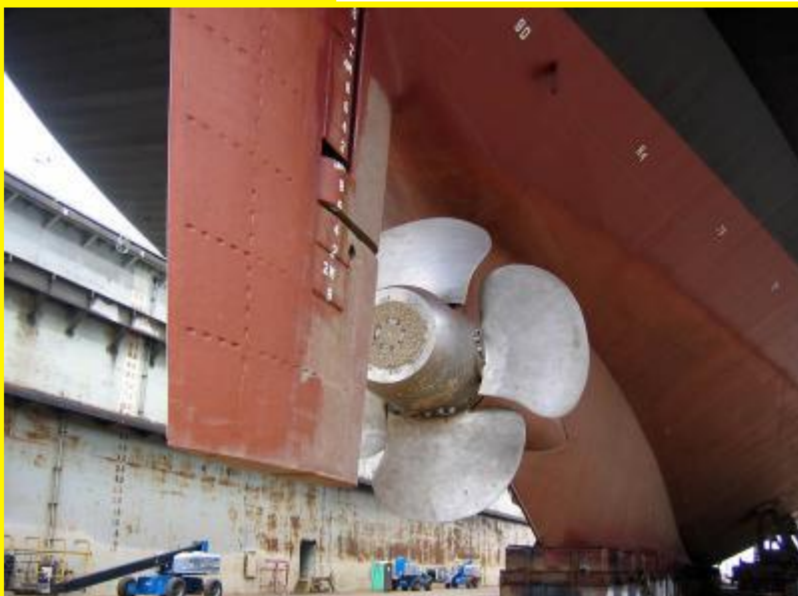
Ships rudder

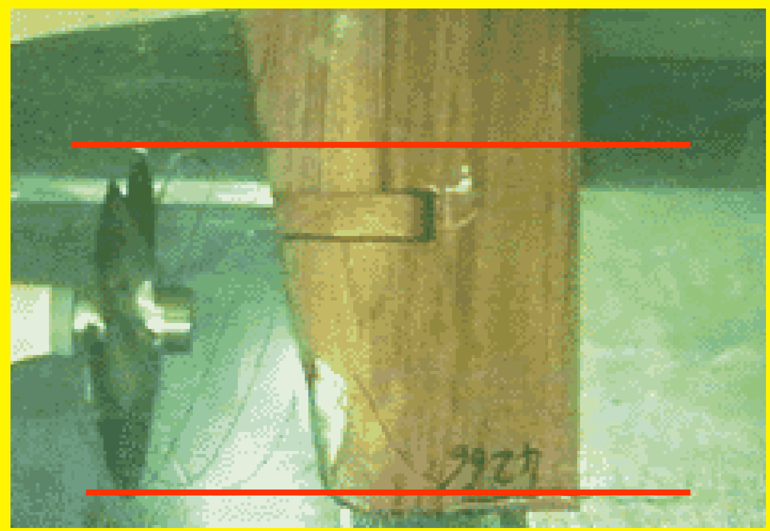




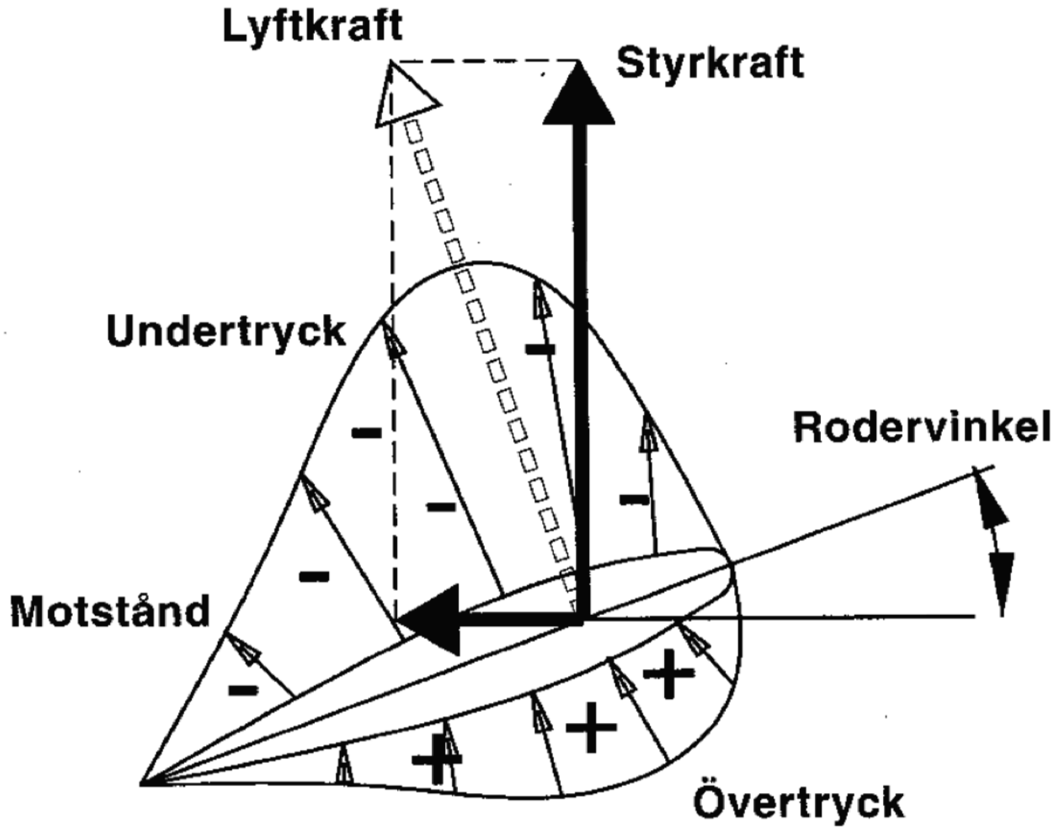
Ships rudder







Roderkrafter



Figur 2

Conventional rudder (minimum area)

Classification guidance

$$A_r = \frac{d \times L}{100} \times \left[1 + 25 \times \left(\frac{B}{L}\right)^2\right]$$

$$\frac{9,5 \times 190}{100} \times \left[1 + 25 \times \left(\frac{32,25}{190}\right)^2\right] = 31m^2$$

"Reed's Naval Architecture for Marine Engineers

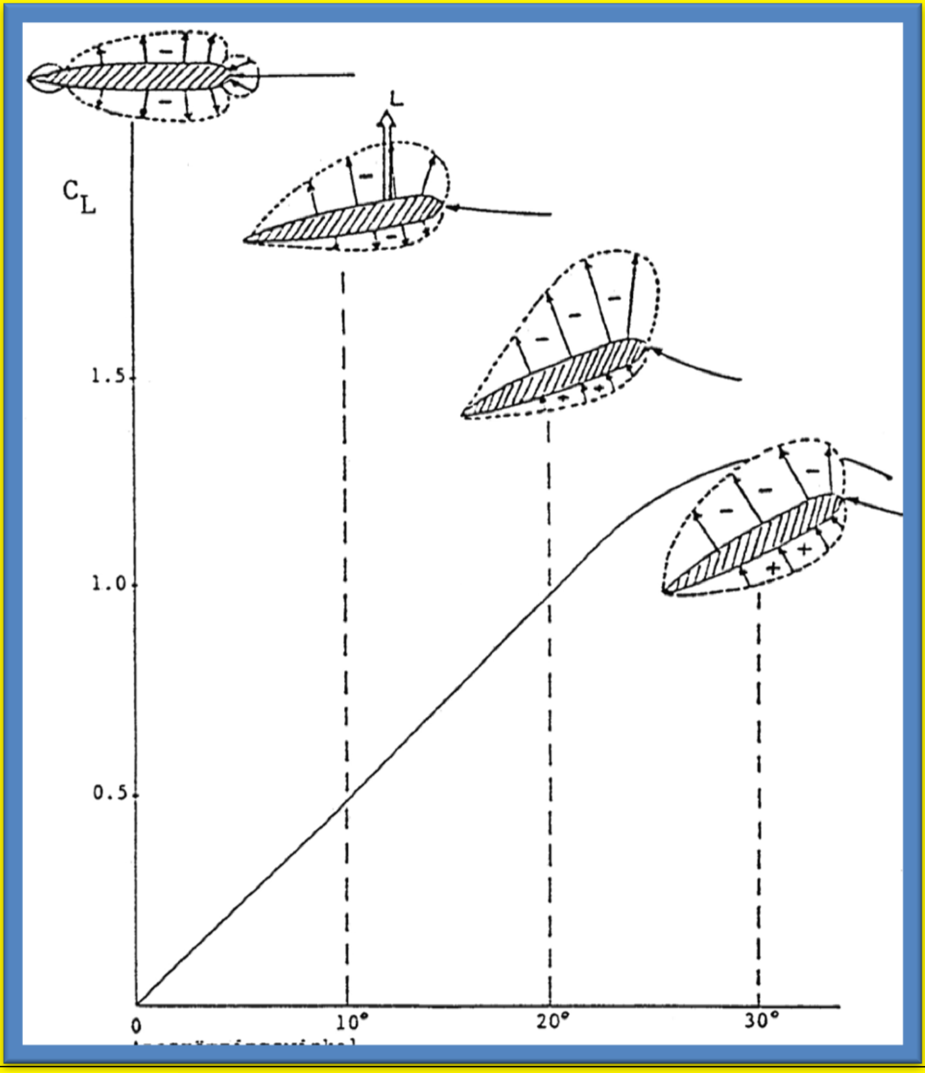
$$A_r = \frac{d \times L}{F}$$

$$\frac{9,5 \times 190}{65} = 28m^2$$

A_r = Rudder Area
d = Ships Draft
L = Ships Length
B = Ships Breadth
F factor between 60 – 70 depending on ships speed

Example
d = 9,5
L = 190
B = 32,25
F =65
Actual area for the ship 39,8 m^2

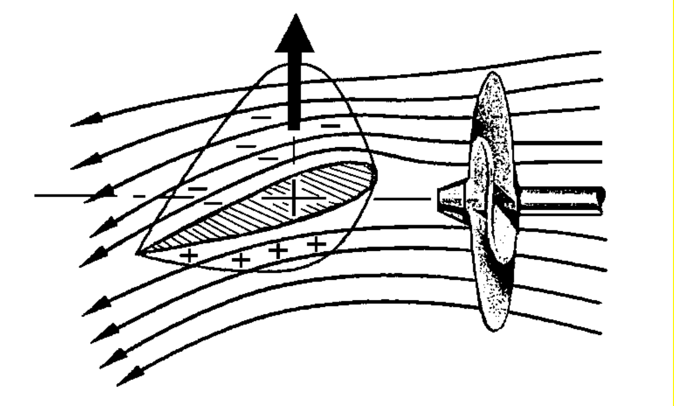
Rodrets lyftkraft



Rudderforce

SSPA (Sjötransporter, farleder och säkerhet)

$$R_F = 1{,}5 \times PD\left(\frac{RPM}{100}\right)^2 - 4 \times \frac{2P - D}{\frac{P}{D}} \times \frac{RPM}{100} \times \frac{V_s}{10} + 9 \times \left(\frac{V_s}{10}\right)^2$$



P = Propeller pitch (m)
D= Propellerdiameter(m)
V_s = Ships speed (knots)
R_F = Maximal rudder force per 10 m^2 rudder area and hard over (ton)
A = Rudder area
(At 15 degrees half rudder force)

Rudderforce;

SSPA (Sjötransporter, farleder och säkerhet

$$4\times\left[1{,}5\times4{,}83\times6{,}35\left(\frac{48}{100}\right)^2-4\times\frac{2\times4{,}83-6{,}35}{0{,}76}\times\frac{48}{100}\times\frac{7}{10}+9\times\left(\frac{7}{10}\right)^2\right]=37\,ton\,/\,18{,}5\,ton$$

$$4\times\left[1{,}5\times4{,}83\times6{,}35\left(\frac{80}{100}\right)^2-4\times\frac{2\times4{,}83-6{,}35}{0{,}76}\times\frac{80}{100}\times\frac{7}{10}+9\times\left(\frac{7}{10}\right)^2\right]=96\,ton$$

Example

a) Rudderforce at 7 knots and 35° and 15°

b) Rudderforce with a short burst of propeller 80 RPM

P = 4,83 m

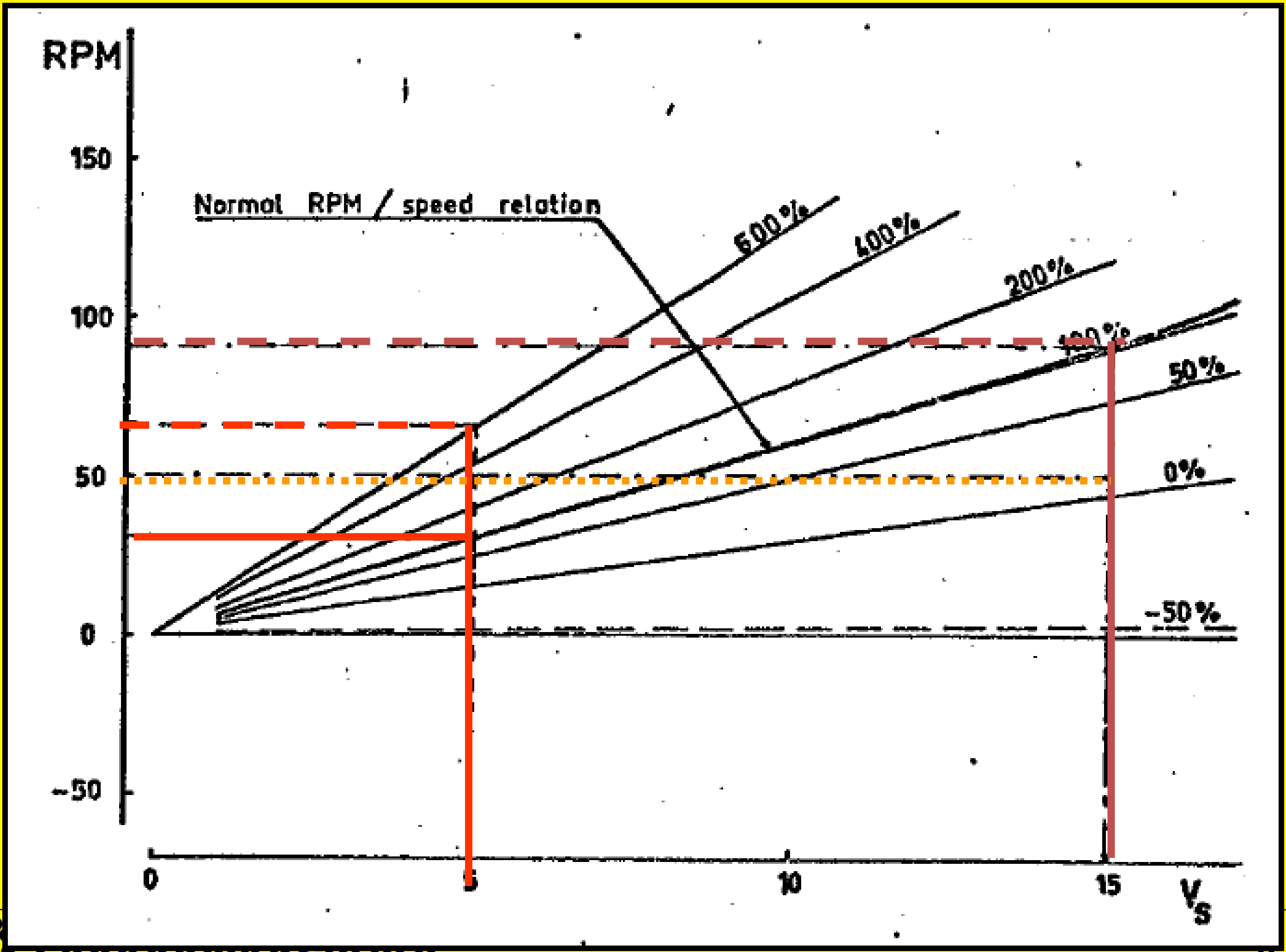
D= 6,35 m

V_s = 7 knots

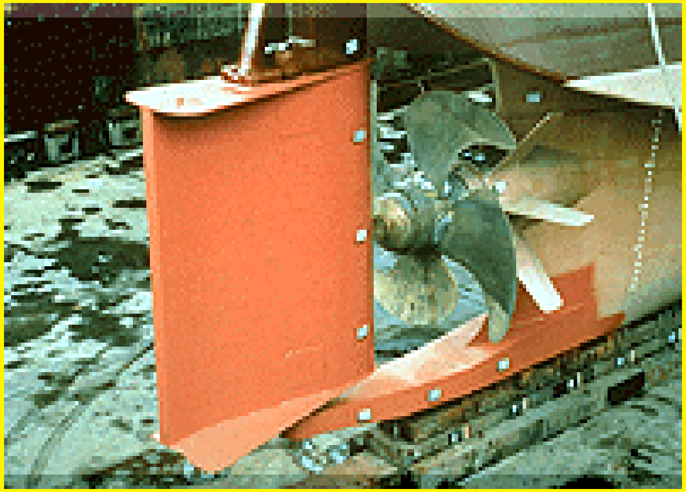
RPM =48 (80)

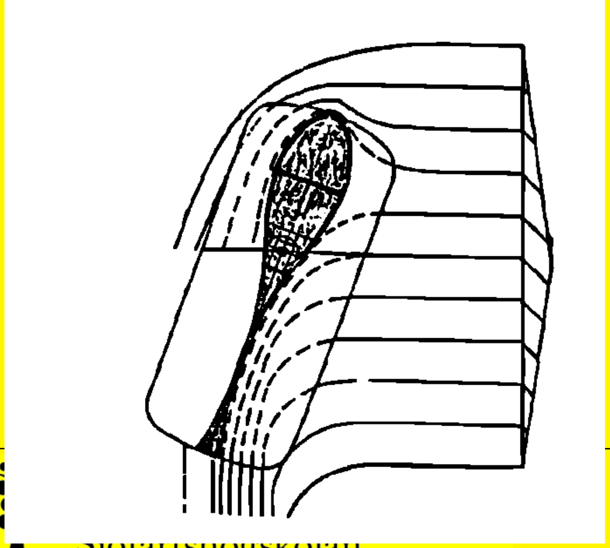
A = 40 m^2

Roderkrafter 98 000 TDW tanker

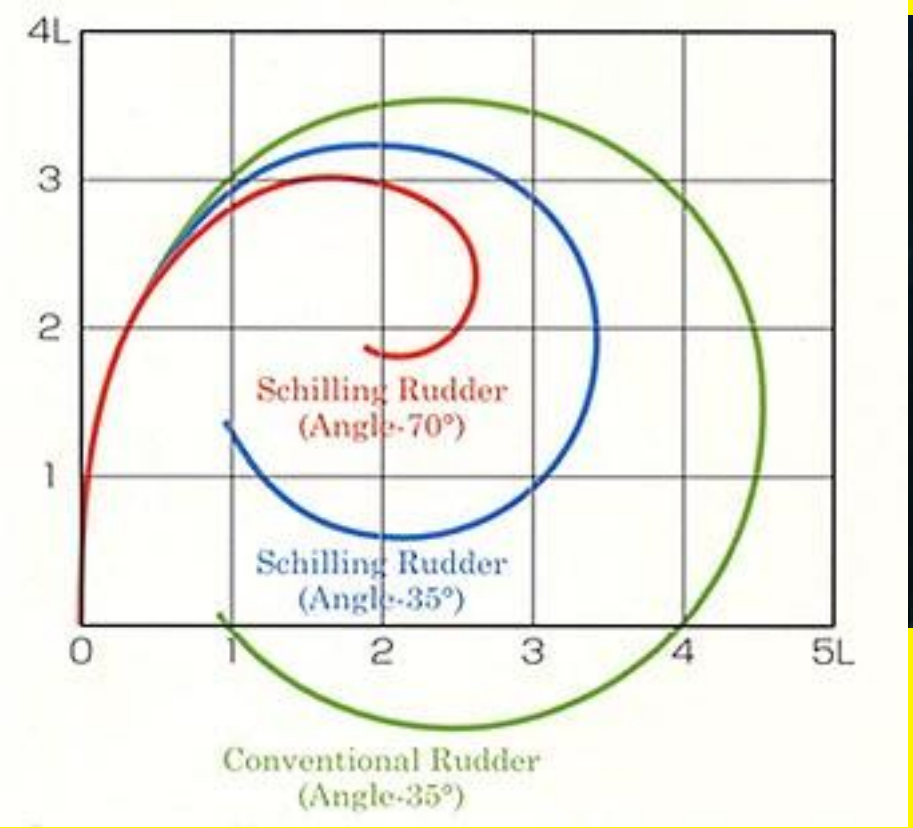


Schilling Rudder

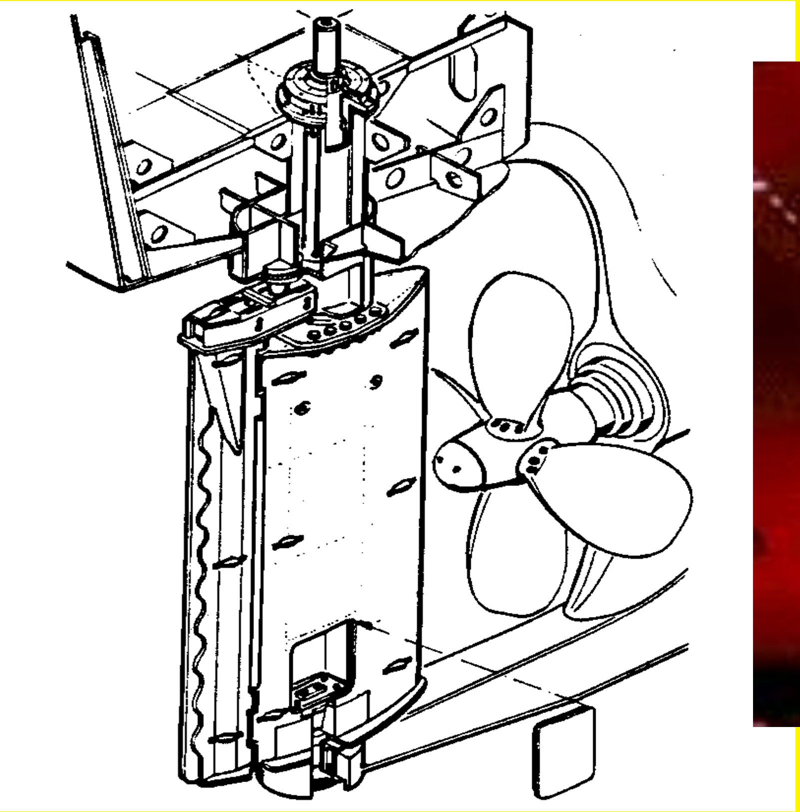




Schilling Rudder



Becker rudder



Own ship power for a normal propeller

~ 0.012 – 0.014 ton/HP

~ 0.016 – 0.019 ton/kW

Example

12 543 kW

12 543 x 0,016 = 200 ton

Bow Thrusters

500 kW	676 Ahk	≈ 6 ton
1000 kW	1351 Ahk	≈ 13 ton
1500 kW	2027 Ahk	≈ 20 ton
2000 kW	2702 Ahk	≈ 27 ton

Bow thruster on a ship built 1925